УДК 681.58

V.P. Dorohobid[1], M.K. Borozdin[1], Ahmed Alzubaydy[2]

[1] *Poltava National Technical University named after Kondratyuk*
[2] *Iraq, University of Dayala College of engineering Electrical power and machines*

DESIGN, IMPLEMENTATION AND TEST A MODEL
OF AN ELECTRICAL ELEVATOR CONTROLLED USING PLC

This paper represents the possibility of controlling an electrical 4-level elevator model using PLC and studying some parameters to ensure its work, this model have been designed and constructed to perform a completed elevator work in an automating technique according to its programming and controlling method that making the connecting much more easier and safer than real relays and complicated wiring method. As well as the PMDC electrical motor that used to drive the elevator cabinet which made the transition from floor to floor much smoother and much efficient than the traditional elevators.

Keywords: elevator, PLC controlling, PMDC motor, DELTA PLC.

Introduction

Some of the improvements that used to achieve more quality and enhancements for the elevator systems can rewards a big difference in working lines, using reliable components to operate for years without any damage, reapplied a new programming when needed in easily way, more accuracy in running, much less time for responding and the easiness of maintenance.

One of the devices that offers such deals is the PLC. The PLC is a small digital computer that saves more space where while offering a lots of central processing unit work, depending on a memory and a number of inputs and outputs terminals. The ladder diagram is a type of PLC programming language based on logic functions in order to run the elevator instructions.

Main part

Working principles. This system represented an electrical elevator depends on some orders that received from the outside control pushbuttons and in the other hands the signals that received from the internal sensors which transmitted the instant change of elevator cabinet position as well as the elevator door case (open or close) these sensors depends on a mechanical action then changed it into an electrical signals that the PLC received it and starting to processing through the ladder logic program which it already saved in the PLC as an instructions to provide the output signals that will be responsible for moving the electrical motors of cabinet and door of elevator. this process will be described in the block diagram shown in (Fig. 1).

Construction. The elevator model designed to meet the required objectives of this work, such as some of a previously completed theoretical studies of a machine model that has been designed. Then to confirm and to implement the simulated model as a prototype certain calculations have been carried out to determine some critical parameters. These parameters includes the size of the cabin, maximum number of persons can be accommodated into the elevator, strength of the rope, type of motor used, motors power rating and torque rating. The using of PLC in the controlling part of this system was contributed to reducing the time waste in other elevator systems, because of the electromagnetic actuators and the contact action which they have a large inertia.

First of all the model build up using aluminum structure for the outer elevator body, then designing the elevator cabin by considering first of all the number of passengers, the capacity of weight and the tension of the rope; all of these will be derived mathematically later.
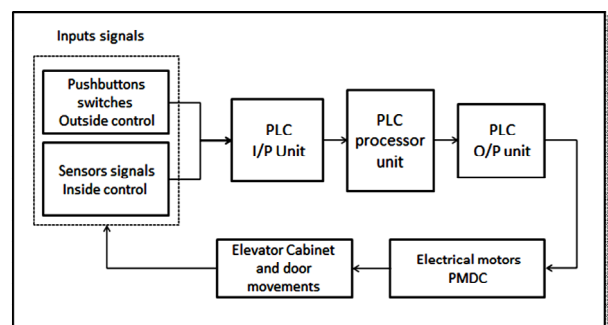

Fig. 1. Electrical elevator block diagram

Elevator controlling. The main part that is responsible on controlling this system is the PLC to overcome the difficulties of relays wiring, using DELTA PLC type, which consist of 16 DC inputs and 8 output relays.

The supply of 24 VDC is given to the PLC , the inputs used is some types of sensors beside the other pushbuttons and 2 outputs electrical motors. This elevator also includes some emergency parts such as (RUN/STOP) manual switch and the firing sensor that added into each elevator floor.

All the wiring details of the PLC with the inputs and the outputs components are shown in Fig. 2.
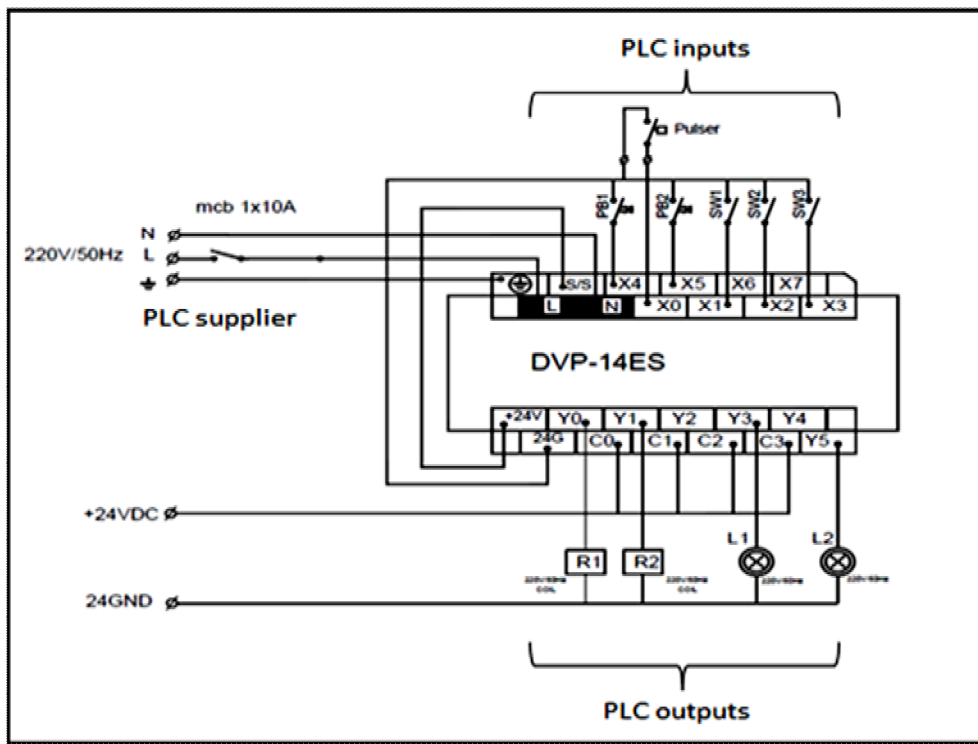
Fig. 2. PLC wiring

PLC inputs. The PLC inputs in this system are of two types, a sensors to detect the motion and the other is a pushbutton switches type for external manual controlling. The sensors used to detect the elevator cabin position and the elevator door case is a magnetic sensor using LDR, as shown in Fig. 3.
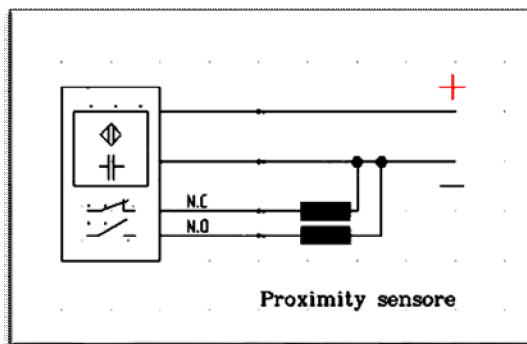

Fig. 3. Proximity sensor

Another type of sensors is used to perform a safety working which is the fire sensor, placing it in the four floors.

In the other hands the pushbuttons are used to call the elevator manually or to start and stop the elevator working, also the elevator working in two cases with AC and DC voltage supply.

The programming of the PLC represented by writing the suitable ladder logic diagram to obtain the required sequences of elevator work, the software that used to writing the ladder diagram is WPLsoft2.39, some ladder steps. Then download it to the PLC using RS232 and RS485.

Mathematical calculations.

1 – Rope strength.

The force which acts on the rope can be found out by the following calculation, as shown in Table 1.

$$F = m \cdot g . \qquad (1)$$

2 – Power calculation for motor.

The motor used here is a PMDC Motors through the practical experimental to determine the parameters & characteristics for steady-state of this type of motors .In another hand the simulation approach are used by mathematical model depending on high technical were available in the computer program (MATLAB). Then the results are compared between both cases . The most important conclusions in this paper are:

a. This type of motors have Efficiency higher than Electromagnetic D.C motors .

b. The damping coefficient (Bm) have negative effect on characteristics of motor especially at no-load steady state in spite of smallness value.
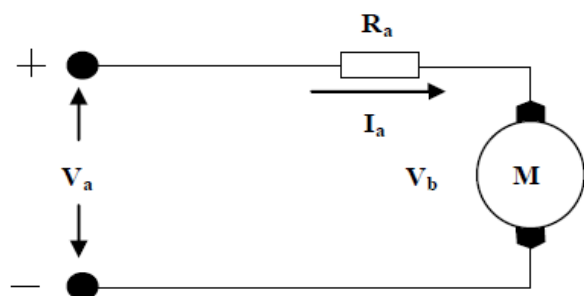
The equivalent circuit for PMDC shown in Fig. 4.

Fig. 4. Equivalent circuit for PMDC

3 – Mathematical model of PMDC.

In ideal case the mechanical power equal to electrical power:

$$T_m \cdot \omega_m = V_b \cdot I_a ; \qquad (2)$$

$$T_m = 9.55 \cdot \frac{P_0}{N} ; \qquad (3)$$

$$T_m \cdot \omega_m = T_L \cdot \omega_L ; \qquad (4)$$

$$V_a = E_b - I_a \cdot R_a ; \qquad (5)$$

$$W = \frac{2\pi N}{60} , \qquad (5)$$

where T_m – mechanical torque;

ω_m – the angular speed of motor;

V_b – the back e.m.f;

I_a – armature current.

Based on the design specification the output power and the output torque of the motor are calculated by a simple calculation.

Power and torque calculation. The gear ratio 1:20.

$$\text{Weight of cabin} = 2\text{kg} \cdot 9.8 = 20\text{N} ,$$

$$R_a = 0.8\,\text{ohm} , \quad I_a = 4\,\text{A} , \quad V_a = 12\,\text{V} ,$$

$$E_a = 8.8\,\text{V} , \quad F_e = 0.2\,\text{m/s} , \quad P_i = 48\,\text{watt} ,$$

$$P_0 = 46\,\text{watt} , \quad \text{eff} = 96\% , \quad K_t = K_v = 0.07 ,$$

$$T_m = \frac{9.55 \cdot 46}{1200} = 0.36\,\text{N} \cdot \text{m} , \quad \omega_m = \omega_L = 1:20 ,$$

$$T_L = 5.6\,\text{N} \cdot \text{m} , \quad N_m = 1200\,\text{r.p.m} , \quad N_m = 60\,\text{r.p.m} ,$$

$$\omega_m = 125.6\,\text{rad/sec} , \quad \omega_L = 6.28\,\text{rad/sec}$$

Wiring of the project. By using CADdy++ program designer the electrical circuits were design and connected with software form to achieve an completed design before connecting it on the real system.

Future work. The researcher will be able to choose this work as a beginning for a complex controlling systems, in the other hand it can be able to use the mathematical calculations of this system as a guide to another work. Also the adding of another PLC to control a more level elevator is possible as well as controlling another elevator by the same PLC at the same time**.**

Conclusion

In this paper the developed design and implementation of the electrical elevator controlled using PLC was studied and discussed . The model includes a ladder logic diagram for running the entire operation of the elevator and some emergency specifications that added a new features to the system. Also adding some suggestions to explain how to develop this elevator in different ways. Finally, it's clear that is the using of DELTA PLC to controlling such systems is a good issue that will be affordable to the industrial world.

References

1. Dae-Woong Chung, Hyung-Min Ryu, Young-Min Lee, Lo-Won Kang, Seung-Ki Sul, Seok-Joo Kang, Jun-Ho Song, Joong-Seok Yoon, Kil-Haeng Lee and Jong-Ho Suh. Drive systems for high-speed gearless elevators // IEEE Industry Applications Magazine, vol. 7, 2001. - P. 52-56.

2. Hong Sun Lim, Krishnan.R. and Lobo.N.S. Design and Control of a Linear Propulsion System for an Elevator Using Linear Switched Reluctance Motor Drives // IEEE Trans. on Industrial Electronics, vol. 55, 2008. – P. 534-542.

3. Hong Sun Lim and Krishnan.R. Ropeless Elevator With Linear Switched Reluctance Motor Drive Actuation Systems // IEEE Transactions on Industrial Electronics, vol. 54, 2007. – P. 2209-2218.

4. Jiang Jing and Zhang Xuesong. Variable frequency speed-regulation system of elevator using PLC technology // 3rd International Conference on Advanced Computer Control, IEEE Conference Publications, 2011. – P. 328-332.

ПРОЕКТУВАННЯ, ВПРОВАДЖЕННЯ І ТЕСТУВАННЯ МОДЕЛІ ЛІФТА, КЕРОВАНОГО ЗА ДОПОМОГОЮ ПРОМИСЛОВИХ ЛОГІЧНИХ КОНТРОЛЕРОВ

В.П. Дорогобід, М.К. Бороздін, Ахмед Альзубайді

В статті представлена модель чотирьохрівневого ліфта, що керується промисловим логічним контролером (ПЛК). Модель дає можливість вивчати параметри об'єкта для розуміння його роботи. Ця модель спроектована і побудована для виконання робіт по програмуванню та підключенню ліфта. Використаний метод є простіший і безпечніший ніж використання релейних схем. Використання електродвигуна типу PMDC, що являється приводом кабіни ліфта, робить рух від поверху до поверху набагато плавнішим і ефективнішим, ніж привод традиційного ліфта.

Ключові слова: ліфт, ПЛК управління, PMDC электродвигун, DELTA PLC.

ПРОЕКТИРОВАНИЕ, ВНЕДРЕНИЕ И ТЕСТИРОВАНИЕ МОДЕЛИ ЛИФТА, УПРАВЛЯЕМОГО С ПОМОЩЬЮ ПРОМЫШЛЕННЫХ ЛОГИЧЕСКИХ КОНТРОЛЛЕРОВ

В.П. Дорогобид, Н.К. Бороздин , Ахмед Альзубайди

В статье представлена модель четырехуровневого лифта, управляемого промышленного логического контроллера (ПЛК). Модель дает возможность изучать параметры объекта для понимания его работы. Эта модель спроектирована и построена для выполнения работ по программированию и подключению лифта. Используемый метод является более простой и безопасный чем использование релейных схем. Использование электродвигателя типа PMDC, что является приводом кабины лифта, делает движение от этажа к этажу гораздо более плавным и эффективным, чем привод традиционного лифта.

Ключевые слова: лифт, ПЛК управление, PMDC электродвигатель, DELTA PLC.